ACCOUNT OF AN EPIDEMIC OF INFLUENZA AMONG AMERICAN TROOPS IN ENGLAND.[1]

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Introduction. The great autumn pandemic of influenza made its first appearance in England with the arrival at the port of Southampton of "Transport 56" from the United States. Following this, nearly every transport that arrived in England for the next four weeks brought large numbers of men either ill with the disease or who subsequently developed it. In addition a considerable number of cases broke out among American troops permanently stationed in England. Those who were most affected were the personnel of hospitals that had received patients.

Altogether, from September 20, 1918, when the above-mentioned transport arrived until the present writing, November 14, 1918, there have been approximately 7800 cases of influenza among American troops hospitalized in Great Britain. Of these, about 5000 have been cared for in American and the balance in British hospitals. Of this total number of cases 3350 developed at sea and occurred among a total of approximately 177,000 troops landed in that period. The morbidity and mortality from influenza among troops landing in England is shown in Table I.

TABLE I.—SHOWING CASES OF INFLUENZA AND DEATHS AT SEA THEREFROM AMONG AMERICAN TROOPS ARRIVING IN ENGLAND.

Week ending.	Cases of influenza landed per 1000.	Deaths at sea per 1000.
Sept. 26, 1918	15.8	0.03
Oct. 3, 1918	36.2	3.68
10, 1918	42.9	7.05
17, 1918	25.2	3.18
24, 1918	8.6	2.60
31, 1918	2.9	0.13
Nov. 7, 1918	6.5	0.00
14, 1918	1.0	0.06

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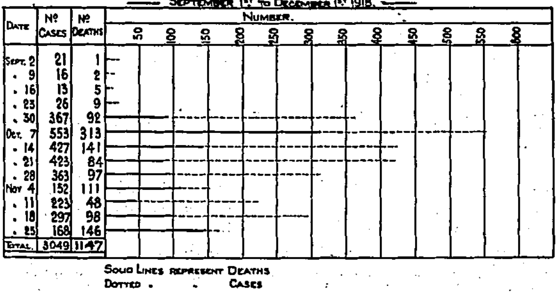
[1] The authors of this paper have all been actively engaged in some phase of handling the influenza epidemic in England, and this paper represents in part a report of their own work. In addition, they have acted in an editorial capacity and consolidated the observations made in all the American hospitals. Their sincere thanks are due to the commanding officers and professional staffs of the several hospitals for their hearty coöperation. Further, an expression of appreciation is in order for the intelligent way that the cases have been handled and studied in all the American hospitals in England. It is hoped that further papers will appear, giving, in greater detail, the experience of various clinics.

In other words, of 177,000 troops landed in the period September 20 to November 14, 1918, 19 per thousand were ill with influenza on arrival and 394, or 2.2 per thousand, died *en route*. The above table also indicates that the importation of influenza had ceased at the present writing. In addition to the imported cases a certain number developed among a fixed American military population of about 28,000. Subtracting those that were ill on arrival from the total we have 4450 developing in England among a combined permanent and transient military population of 205,000. This makes the observed morbidity of influenza 10 per thousand per month for the period September 20 to November 14, 1918. The actual morbidity is undoubtedly higher, for cases probably developed in the transient troops during the period but after their departure from England. Of these latter cases the writers have no information. There was a total of 900 deaths in England during the period, or a mortality of 2 per thousand per month. Of the total cases of influenza, both on land and sea, 16.5 per cent. died during the period.

The influenzal process was frequently complicated by bronchopneumonia, and this complication, except in rare instances, was the cause of death. Of the total cases of influenza hospitalized, about 2300, or 29.5 per cent., developed pneumonia, and of these 900, or 39 per cent., died. When the cases dying at sea are included the percentage of pneumonia cases dying becomes 60 per cent. Assuming the average length of voyage to be about two weeks, it will be seen that the mortality at sea is about double that on land.

There has not been sufficient clerical force available to show the admission to hospitals of cases of influenza by weeks, but Chart I, which shows the total of cases of pneumonia hospitalized in England by weeks and the deaths therefrom, will give a good idea of the progress and severity of the epidemic. (See Chart I.)

CHART No I.—SHOWING NUMBER OF CASES OF PNEUMONIA AND DEATHS THEREFROM. AMERICAN TROOPS, ENGLAND.
— SEPTEMBER 1ST TO DECEMBER 1ST 1918. —



DATE	No CASES	No DEATHS
SEPT. 2	21	1
. 9	16	2
. 16	13	5
. 23	26	9
. 30	367	92
OCT. 7	553	313
. 14	427	141
. 21	423	84
. 28	363	97
NOV 4	152	111
. 11	223	48
. 18	297	98
. 25	168	146
TOTAL.	3049	1147

CHART I

EPIDEMIOLOGY. It has not been possible to make detailed statistical studies of all the individual ship epidemics nor of the incidence among permanent personnel as a whole. Such studies, however, have been made in a few instances, and will, by way of illustration, give an excellent idea of the various aspects of the outbreak.

EPIDEMIC OF "TRANSPORT 56." This epidemic, which is one of the most severe of the group, has been studied in great detail, and since it can be followed from start to finish, forms an excellent illustration.

The transport left an American port on September 14 with 5951 troops on board. When two days from port a medical inspection of the entire personnel showed 7 cases of measles, 1 of which developed bronchopneumonia and died on September 21. During the voyage there developed 14 cases of mumps, 16 of measles, 4 of scarlet fever, 3 of pneumonia and a number of cases of acute respiratory tract infection (influenza). The latter rapidly assumed epidemic proportions, as will be seen in Chart II, which shows the daily incidence of such cases both during the voyage and among the troops after debarkation. (See Chart II.)

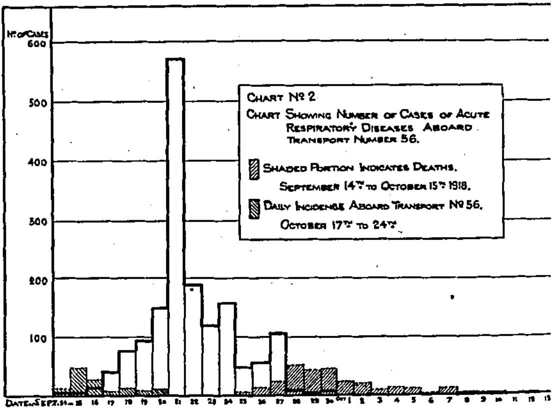
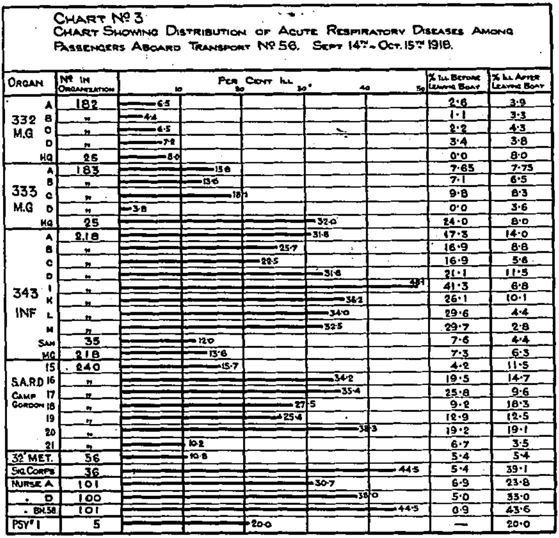


CHART II

The ship reached an English port on September 21, the high point of the epidemic, and it was probably the debarkation of troops that prevented the further spread of the disease.

The ship's sanitary report shows that early in the voyage sanitary conditions on board were satisfactory, but that on September 21, when the great incidence occurred, great difficulty was experienced in properly caring for the patients, and the general sanitary condition became bad.

Owing to transportation difficulties it required several days to get all the sick off the vessel, and they were not all clear of her until September 25. The troops not ill were sent to an American rest camp in the vicinity. During the period from September 23 to September 27 many cases developed in this camp, which appear in Chart II, but by October 1 the epidemic had practically ceased. The conditions in the rest camp were better than on board ship, but even then there was much overcrowding, the camp containing 29 per cent. above its normal capacity. (See Chart III.)



Organ	Nº in Organization	Per Cent Ill	% Ill Before Leaving Boat	% Ill After Leaving Boat
332 M.G A	182	6·5	2·6	3·9
B	"	4·4	1·1	3·3
C	"	6·5	2·2	4·3
D	"	7·2	3·4	3·8
HQ	25	8·0	0·0	8·0
333 M.G A	183	15·6	7·65	7·75
B	"	13·6	7·1	6·5
C	"	18·1	9·8	8·3
D	"	3·8	0·0	3·6
HQ	25	32·0	24·0	8·0
343 INF A	218	31·8	17·3	14·0
B	"	25·7	16·9	8·8
C	"	22·5	16·9	5·6
D	"	31·8	21·1	11·5
I	"	48·1	41·3	6·8
K	"	36·2	26·1	10·1
L	"	34·0	29·6	4·4
M	"	32·5	29·7	2·8
San	35	12·0	7·6	4·4
MG	218	13·6	7·3	6·3
S.A.R.D Camp Gordon 15	240	15·7	4·2	11·5
16	"	34·2	19·5	14·7
17	"	35·4	25·8	9·6
18	"	27·5	9·2	18·3
19	"	25·4	12·9	12·5
20	"	38·3	19·2	19·1
21	"	10·2	6·7	3·5
32d MET.	56	10·8	5·4	5·4
Sig. Corps	36	44·5	5·4	39·1
Nurse A	101	30·7	6·9	23·8
" D	100	38·0	5·0	33·0
" BN.58.	101	44·5	0·9	43·6
PSYt I	5	20·0	—	20·0

Chart III

In Chart III the incidence among the various organizations on board will be found. It will be noted that some units had a greater number become ill before leaving the ship, others after. The nurses in particular showed a much higher incidence on shore than before landing. This is easily explained by the fact that they were assigned to duty on the ship and in the various hospitals caring for the ill soldiers.

Chart IV was prepared in order to determine how many cases developed after arrival in hospital. It will be seen that 317 cases, or 74.3 per cent., of the total had already developed before the cases were hospitalized. A few cases developed during the first and second days after admission, and in one hospital there was a considerable outbreak twelve to thirteen days later. (See Chart IV.)

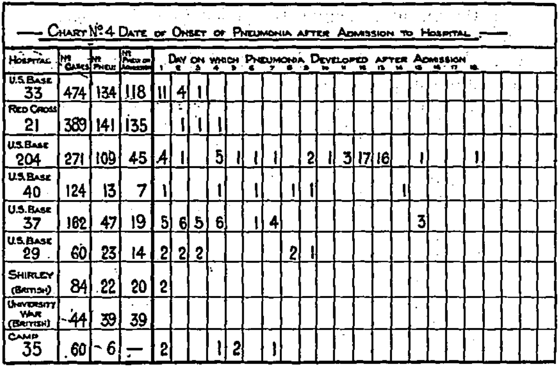


CHART Nº 4 DATE OF ONSET OF PNEUMONIA AFTER ADMISSION TO HOSPITAL

HOSPITAL	Nº CASES	Nº PNEU.	Nº PNEU. ON ADMISSION	DAY ON WHICH PNEUMONIA DEVELOPED AFTER ADMISSION																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18				
U.S. BASE 33	474	134	118	11	4	1																			
RED CROSS 21	389	141	135		1	1	1																		
U.S. BASE 204	271	109	45	4	1		5	1	1	1		2	1	3	17	16		1			1				
U.S. BASE 40	124	13	7	1			1		1		1	1					1								
U.S. BASE 37	162	47	19	5	6	5	6		1	4								3							
U.S. BASE 29	60	23	14	2	2	2					2	1													
SHIRLEY (BRITISH)	84	22	20	2																					
UNIVERSITY WAR (BRITISH)	44	39	39																						
CAMP 35	60	6	—	2			1	2		1															

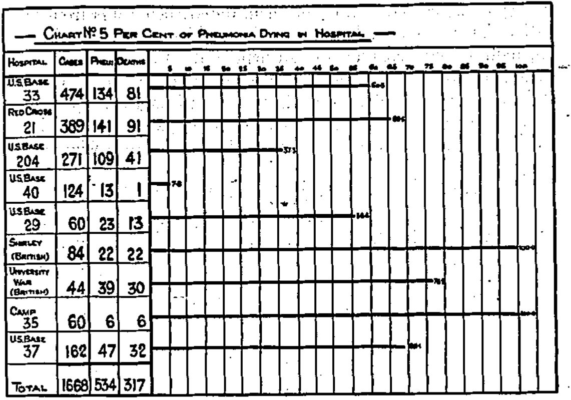
CHART IV

In one hospital, which was located 180 miles from the port of debarkation, 96 per cent. of the cases admitted already had pneumonia on arrival, while in another hospital, distant only eight miles, only 41.5 per cent. had pneumonia on arrival.

The uniformly high death-rate of the pneumonia is shown in Chart V, which gives the percentage dying in each hospital. It may be said that in the two British hospitals listed therein, where the mortality was very high, the cases were practically moribund on admission, and at C.H. 35 there were post-measles pneumonia. In general, however, the severity of the disease seemed to bear some direct relation to the distance the patients were transported. (See Chart V.)

In order to gain some idea about the general condition of the troops, information was obtained of the size of their home towns. This data is shown in Chart VI. It appears that two-thirds of the patients came from towns having a population under 6000. As to the State from which they came it was found that about one-quarter were from Wisconsin and a considerable proportion were from Minnesota and Illinois. A study of their pre-war occupations disclosed the fact that about 58 per cent. were from farms. (See Chart VI.)

It is interesting to note the length of time that these patients had been in the service. In Chart VII it will be seen that 41 per cent. began their military training in July, 23 per cent. in June and 10 per cent. in May, 1918. They were therefore for the most part not hardened to the conditions of warfare, and hence were particularly susceptible to a virulent infection. (See Chart VII.)


— CHART Nº 5 PER CENT OF PNEUMONIA DYING IN HOSPITAL —

HOSPITAL	CASES	PNEU.	DEATHS
U.S. BASE 33	474	134	81
RED CROSS 21	389	141	91
U.S. BASE 204	271	109	41
U.S. BASE 40	124	13	1
U.S. BASE 29	60	23	13
SHIRLEY (BRITISH)	84	22	22
UNIVERSITY WAR (BRITISH)	44	39	30
CAMP 35	60	6	6
U.S. BASE 37	162	47	32
TOTAL	1668	534	317

CHART V

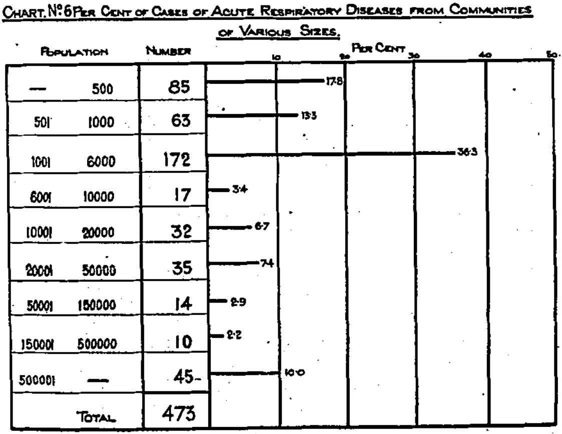


CHART. Nº 6 PER CENT OF CASES OF ACUTE RESPIRATORY DISEASES FROM COMMUNITIES OF VARIOUS SIZES.

POPULATION		NUMBER	PER CENT
—	500	85	17.8
501	1000	63	13.3
1001	6000	172	36.3
6001	10000	17	3.4
10001	20000	32	6.7
20001	50000	35	7.4
50001	150000	14	2.9
150001	500000	10	2.2
500001	—	45	10.0
TOTAL		473	

CHART VI

Information was asked from many concerning the details of their journey. Considerable evidence of debilitating conditions was obtained. For instance, practically all complained that the shower bath which they had once or twice during the voyage was a severe ordeal. They said they were obliged to remain undressed, without covering, for a considerable period and then passed through a shower of sea-water. Many of them dated their colds from these baths. They also complained that the food issued in the ration was unpalatable and that they ate but little of it. Instead, they bought such articles of food as crackers, sardines and candy at the Canteen and ate at irregular intervals. Altogether, their method of obtaining food was sufficient to derange their digestive systems and probably did not give sufficient nourishment. Most of the men who became ill had to sleep in hammocks. They complained that the lights were on all night and that the air in their quarters was foul, so that they were unable to sleep. It is evident that the nervous tension, which was quite unavoidable, owing to the circumstances of the voyage, made it impossible for the men to receive proper rest during the trip.

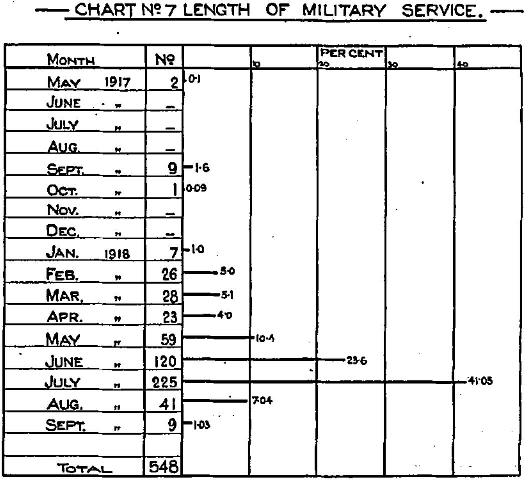


CHART VII

Inquiries were made relative to the illnesses which patients had had during the previous six months. These disclosed the fact that only about 126 had been ill. The illnesses complained of in order of their frequency were measles, gastric disturbances, rheumatism, malaria, mumps, pneumonia and influenza. The number giving a past history of pneumonia within six months was eight and of influenza seven.

To sum up, "Transport 56" arrived at a British port with 5951 troops. It left the United States on September 14 and arrived on September 21. On the day of arrival 574 cases of influenza developed. By October 15, 1668 cases had developed, which is about 28 per cent. of the total number of troops. Of those who thus became ill, 534, or 32 per cent., were complicated by pneumonia, and of these 317, or 19 per cent., died. Of those who developed pneumonia, 59.3 per cent. died. These figures are strikingly like those previously given for the entire epidemic in England.

The morbidity and mortality by weeks for this epidemic are shown in Table II.

TABLE II.—INCIDENCE AND DEATH.

Rate per 1000 per month from influenza. Transport 56. First epidemic.

Week ending	Morbidity.	Mortality.
September 20	264	...
September 27	836	30
October 4	16	140
October 11	...	17

In marked contrast to this experience is the next voyage of the same transport. She again left the United States on October 17 and arrived in England on October 24, with scarcely more than a normal amount of sick, although a mild epidemic had been in progress during the trip. The incidence of influenza on the second trip is also indicated in Chart II.

The following extracts from the report of the transport surgeon are of extreme interest:

"Troops were all examined and their temperatures taken before the ship sailed and over 167 cases of influenza removed to shore.

"A general daily examination was made of all the troops and an evening temperature taken of the units by a medical officer.

"All on board were treated as contacts. Gauze masks were worn by all troops and the nose and throat sprayed with iodin and albolene solution, 1 gr. to 1 oz., twice daily. The last spraying was done before bedtime.

"The first day out of port, from 4 P.M., October 17 to October 18, 7 A.M., 11 new cases were reported. Second day to October 19, 7 A.M., 47; third day to October 20, 7 A.M., 17; fourth day to October 21, 7 A.M., 8; fifth day to October 22, 7 A.M., 14; sixth day to October 23, 7 A.M., 9; seventh day to October 24, 7 A.M., 11. These cases include 11 not of influenzal origin.

"Fifteen cases of pneumonia developed.

"Conclusion. These precautions seem to control an undoubted epidemic."

This epidemic of 117 cases among 5430 troops, with 15 cases of pneumonia and no deaths at sea, showed an incidence of 86 per 1000 per month, and 13 per cent. of the total cases of influenza developed pneumonia. It is further noteworthy that no increase in the epidemic occurred after debarkation.

From the second voyage of "Transport 56" it might be concluded that the measures taken—namely, masking of all souls on board, spraying daily and segregation of those with fever—prevented a widespread epidemic. This conclusion is not justified, however, because it happened that at about the same time another transport, the "Anchises," from the same port of embarkation, and loaded with troops from the same camp in the United States arrived at a British port with no cases of influenza, despite the fact that the only precautions taken were daily observation of the temperatures and segregation of those with fever. Further examination disclosed the fact that the troops on both these ships had passed through an epidemic before sailing and were therefore made up of those who had resisted this infection.

EPIDEMIC OF "CONVOY 46." The first trip of "Transport 56" shows what happened on a fast ship. The following brief account of what occurred on a slower vessel is also worthy of note: Steamship "Nestor" left New York on September 17 with 2807 troops on board. No illness appeared until two days out, at which time several cases of influenza appeared in one hold. The ship put in at Sydney, N. S., on September 20, and Colonel Spitska, the S. M. O., insisted that all sick, together with contacts, be landed. This was done and somewhat over 600 men were put ashore.

The ship then proceeded on her voyage, and *en route* somewhere in the vicinity of 60 per cent. of all those on board developed influenza. Many of these had recovered by the time she reached port on October 2. There were 21 deaths at sea, or 9.5 per thousand, about 19 per thousand per month. The incidence of influenza was somewhere in the neighborhood of 1200 per thousand per month. The sanitary conditions on board the transport were bad. She was overcrowded and the ventilation was poor.

These two ship epidemics present the two extremes found. In one instance a fast ship with the epidemic breaking out toward the end of the voyage and checked by debarkation, in the other a slow ship with an epidemic raging for two weeks and on the decline when she reached port. Other ships presented similar or intermediate pictures. The epidemic in this case suggests what a very serious state of affairs might have occurred in "Transport 56" had not the troops been promptly debarked.

EPIDEMIC AT BASE HOSPITAL 29. As an example of how fixed personnel occasionally became involved a brief statement of an epidemic occurring among the personnel of Base Hospital 29 may be of interest. This hospital received a convoy of 60 cases of influenza from "Transport 56" on September 24. Table III shows the incidence of influenza and the death-rate among the hospital personnel following the receipt of the convoy.

TABLE III.—SHOWING INCIDENCE INFLUENZA AND DEATH-RATE PER 1000 PER MONTH. PERSONNEL OF BASE HOSPITAL 29.

Week ending	Morbidity.	Mortality.
September 28	80	0
October 4	180	0
11	220	0
18	500	48
25	180	36
November 2	100	12

Other hospital personnels were affected, but not as seriously. The high incidence in Base Hospital 29 can be explained very likely by the fact that it is situated in a crowded portion of London where influenza was quite prevalent among the local population. Also, perhaps, partly because this organization, having fairly recently come from a high dry climate in the States, may have been less acclimatized to the damp weather prevalent in England than were other organizations.

Clinical Features of Disease. To get an accurate description of the clinical features of the disease under discussion an attempt has been made to collect and consolidate the observations of the medical officers in charge of the cases in all of the American hospitals in England. From the reports received and from the observations of officers visiting the several hospitals in turn it becomes apparent that we are dealing with a definite clinical entity, presenting essentially similar features in cases derived from different sources and localities.

The patients were largely received from incoming transports from America, though a certain number developed among the medical and nursing personnel and patients in hospitals for other conditions, apparently as a result of direct contact. The state of advancement of the disease varied somewhat among the groups received from various ships. Thus in the case of the rapid "Transport 56," the epidemic had only assumed alarming proportions on the day of arrival in port, so that many cases developed, and practically all the deaths occurred on shore.

With the slower ships, such as the "Nestor," taking from fourteen to fifteen days, on the other hand, the epidemic had often apparently involved the greater portion of the susceptible persons on board, and many of the patients received by the hospitals after the ship's arrival were in the most serious stages of the disease.

Histories were not always obtainable, but in general the stories told and the onset observed in the cases that developed under observation present a similar picture.

ONSET. The onset is, as a rule, sudden, with fever, chilly sensations or rigors and oftentimes a marked degree of prostration. Aching in the extremities and back and chest were often complained of, and headaches occurred in a considerable proportion. Muscle tenderness was frequent. Previously to this sudden onset many of the patients had been quite well. This applies particularly to the cases that developed in England, but in many of those that developed on board ship there were histories of common colds, sea sickness and exhaustion for several days previously. Coughing, with a mucopurulent sputum, occurred from the start in practically all of the cases. In addition a certain number showed a definite coryza, with sneezing, not, however, with conjunctivitis as in measles. Sore-throat was occasionally present, but was not a common feature. Hoarseness may occur in the later stages, but not usually in the beginning.[2] The sputum even on the first day or two of the disease was occasionally streaked with fresh blood, and epistaxis was often seen. The pulse in such early cases was usually full and bounding, of good tension and the rate varying with the temperature from 80° to 120°.

UNCOMPLICATED INFLUENZA. All cases having started as outlined above, developed further in one of two definite ways: They either ran an uneventful course of from three to seven days, ending in recovery, or they developed a most serious type of bronchopneumonia. The former group, which we may call simple influenza, comprised from 60 to 70 per cent. of the whole. Of the course of these uncomplicated cases there is nothing of any great moment to relate. The fever continued generally from one to seven days, but usually from two to four days, and then fell either by crisis or rapid lysis to normal. With the fall in temperature the toxic symptoms cleared, if they had not previously, and oftentimes the patients would feel entirely recovered. In many cases a considerable degree of prostration persisted for several days. The cough usually persisted for a week or more and the patients continued to raise a small amount of purulent sputum after they were, in other respects, quite well. During the fever there was nearly always a considerable degree of anorexia and often profuse sweating. Abnormal signs in the chest in the cases of simple influenza were often entirely lacking, or in a certain number there might be a few scattered rales and ronchi. The patients were usually flushed and occasionally slightly dusky in appearance. The eyelids often were slightly puffy. Sometimes transient erythemas were noted over the trunk or extremities, but there was no characteristic exanthem or enanthem. To sum up: the picture was that of an acute infection of the upper respiratory tract, with very sudden onset and marked toxemia, and because of its epidemic form, evidently highly contagious.

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[2] In regard to laryngeal involvement the following report, by Captain William M. Bane, of *Base Hospital No. 29*, is of interest:

"Among the 235 cases of influenza and the 54 cases of pneumonia which have been cared for in this hospital from September 1, 1918, to October 25, 1918, there have occurred 9 cases of laryngitis, 6 of which developed only hoarseness and cough and 3 a complete aphonia.

"The type observed has been invariably an acute catarrhal aryngitis. The active cause is infection by invading organisms which gain entrance into the mucosa when its resistance has been lowered by one or more of the following: Irritating cough, toxins evolved from diseased nasal mucosa, accessory sinuses or pharynx; inspiration of air improperly moistened, warmed and filtered by reason of nasal obstruction. The influenzas and pneumonias almost all show inflamed and swollen mucous membranes in the nose and throat, and mouth breathing is commonly observed. Sinusitis, especially frontal, has been very common.

"Of the subjective symptoms, alterations in voice and the cough have been constant, but pain has been very uncommon. Objectively, very slight swelling and hyperemia of the cords and adjacent mucosa have been observed, but no cases in which there was any edema, hemorrhagic areas or ulcerations have been seen.

"As to prognosis it seems that the infection, although quite virulent, has attacked the upper respiratory tract much less severely than the lower part, so that the outcome from the laryngitis is usually good.

"Treatment has consisted essentially of limitation in the use of the voice, complete rest where possible and mild inhalations of tincture benzoin comp. and steam every three hours. The inhalations were not only beneficial to the mucosa of the throat but usually very soothing to the patient with severe bronchitis. Appropriate treatment to the nose, accessory sinuses and tonsils is essential. The cases with complete aphonia regained the use of the voice in about three days, followed by a prolonged period of hoarseness. Another case with aphonia proved to be hysterical."

INFLUENZA PNEUMONIA. We come now to the second type of the disease, which in reality seems to constitute what might be termed a superimposed epidemic and which took the form of an exceedingly fatal type of bronchopneumonia closely associated with a purulent bronchitis, and which is responsible for practically all the deaths occurring in the epidemic. This bronchopneumonia, though most probably caused by a different infectious agent from the original disease, bears a close relationship to the latter, inasmuch as it presents some very characteristic features which differentiate it from ordinary pneumonia, and because, so far as we can learn, it never appears out of a clear sky in a healthy individual but only in persons already suffering from influenza.

The pneumonia may begin anywhere in the course of the simple influenza, sometimes as early as the second day. It is ushered in by an apparent increase in the toxicity of the patient, by an increase in the rate of respiration and the early development of cyanosis. The physical signs of consolidation appear usually at one or both bases, though occasionally consolidation has first been noted in one of the upper lobes. At the same time there is generally found an increase in the amount of moisture in the chest, as shown by the presence of numerous moist rales scattered throughout. The sputum becomes more purulent and contains considerable quantities of fresh blood. Epistaxis also was exceedingly frequent. The course may be exceedingly fulminating, death occurring as early as the second or third day. In such cases the signs of consolidation rapidly extend, one lobe being involved after another in an almost explosive fashion, so that death may occur from mechanical asphyxia so great is the lung involvement. Other cases run a more prolonged course.

Patients may continue with the disease for two weeks and ultimately succumb. In such the consolidation is liable not to be particularly extensive, but the purulent bronchitis is a more prominent feature and the cause of death apparently is toxemia. Between these two types all grades of intermediate varieties were found. The temperature curve in the fulminating cases was apt to be continued high anywhere from 102° to 105°, the pulse varying from 100 to 130. Shortly before death the temperature would rapidly drop and the pulse rapidly rise. In the more chronic cases the temperature was liable to be very irregular, a septic temperature in fact. The cases that recovered usually showed a gradual lysis, though the crisis was occasionally observed. A pseudocrisis, followed by a resumption of fever of the irregular type, was more frequent. The respiration was nearly always increased in rate, and often shortly before death exceedingly rapid, sometimes as high as sixty per minute. It was apparently a tachypnea rather than a true dyspnea, however, for except in the moribund cases it was usually not a source of discomfort to the patient. Certain very striking differences between the influenza pneumonia and ordinary lobar pneumonia have impressed themselves upon practically all the officers who have had patients in their charge. In the first place the general appearance of the patient is unlike the usual pneumonia. In spite of his rapid breathing there is a striking absence of orthopnea; in fact, he usually lies flat by preference. There is almost never any pleural pain, and although an occasional friction rub has been heard it is exceptional. The painful grunting breathing of lobar pneumonia is almost invariably absent. The tenacious, tawny or rusty sputum of true pneumonia is not seen, but instead an abundant mucopurulent sputum, with considerable fresh, bright red blood is the rule. Another characteristic feature is the early developing and profound cyanosis seen in all the severer cases. It is of a peculiar tint, a deep lavender or heliotrope. As a rule the intensity of this cyanosis bears no definite relationship to the degree of consolidation. It may be as deep in the primarily purulent bronchitis cases in which there is little consolidation as in the fulminating cases with extensive consolidation. Moreover, no cause for it can be discovered in the circulation. No dilatation of the right heart can be made out on physical examination, and this is in part borne out by the autopsy findings; nor is the pulse necessarily of poor quality nor the blood-pressure low. A recent paper by Hoover[3] is extremely interesting in this connection, and his views on the importance of foam in the bronchial tree may explain the non-relationship of cyanosis and degree of consolidation seen in these cases. As Hoover points out the presence of foam in the bronchial tree will cause a marked hindrance to gas exchange in the lungs, and as most of these cases of influenza pneumonia have considerable moisture in the chest, their cyanosis may well be explained on that basis.

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[3] Moisture in the Air Spaces of the Lungs and Oxygen Therapy, Jour. Am. Med. Assn., September 14, 1918, lxxi, 880.

It should also be emphasized that epistaxis is frequent and highly characteristic of the disease.

Certain other noteworthy manifestations and complications have been observed. A moderate number of cases presented the signs of meningismus, and these were relieved by lumbar puncture, the fluid being sterile, but under pressure. Another striking occurrence was the development, in a few cases, nearly every hospital had one or two, of a subcutaneous emphysema of the neck and upper chest. This was unquestionably of mechanical origin, for it was never accompanied by any inflammatory process. It was as though air had been introduced beneath the skin and was unaccompanied by any redness or induration. The cause of this phenomenon has not been definitely established, but in one case that came to autopsy the emphysema was found to extend downward along the course of the trachea through the mediastinum and about the pericardium. Moreover, several cases at autopsy which had not presented emphysema of the neck during life showed emphysema in the mediastinum and about the pericardium, and one showed blebs of air over the visceral pleura. It seemed most likely that the air escaped into the lung, and following the course of the large bronchi made its way through the lung root and along the course of the trachea to the neck. In no instance was this condition associated with pneumothorax, nor was any case found at autopsy in which there might have been an escape of air from the lung through adhesions to the mediastinum. Rupture of the trachea or main bronchi was not found.

An occurrence which may or may not be accidental was the development in some of the cases, which had either had or were having influenza pneumonia, of meningococcus meningitis. This occurred in at least 30 cases, 20 of them being in one hospital. This uneven distribution suggests that the incidence of cerebrospinal fever was not causally related to the influenza, except in so far as the influenza might have been predisposing. Three cases of pneumococcus meningitis were reported.

Evidence of disease of the accessory sinuses of the nose was frequently found, as was also purulent otitis media. It is interesting to note in this connection that out of 26 autopsies in which the head was explored, empyema of one or more of the accessory sinuses was found in 21.

One case of undoubted acute endocarditis was found clinically and two at autopsy. Systolic murmurs at the apex were not infrequent, and in the cases that recovered, rapidly disappeared. Pericardial friction rubs have not been reported.

Abdominal complications beyond the distention often seen in pneumonia were lacking. Enlargement of the spleen demonstrable on physical examination was rare. A few cases presented nausea and vomiting and acute abdominal pain.

Jaundice occurred in a small percentage of the cases.

An exceedingly interesting complication was observed at American Red Cross Hospital 4. Fifteen cases presented swollen, painful feet, and several of these showed acute red inflammatory areas over the toes and instep from 1 to 2 cm. in diameter. Two cases also showed blebs and bullæ over the shins. It was thought that there might have been septic thrombosis or embolism, the red areas being similar to those described by Osler in malignant endocarditis.

A negative feature of the epidemic, which is rather striking, is the comparatively low incidence of empyema.

Clinical Pathology. *Sputum.* The gross appearance of the sputum has already been described. The points to be emphasized in the pneumonia cases are its abundance and its striking difference from ordinary pneumonic sputum, in that in place of a tenacious rusty sputum there is found a yellow purulent sputum with abundant streaks of fresh blood.

Films of the sputum show usually a varied flora. Influenza-like bacilli were frequently found but so, too, were a variety of other organisms, having, for example, the morphology of pneumococcus or streptococcus.

Blood. Blood counts were not done systematically, but when done were of considerable interest. In the simple influenza the white count was usually low, 5000 cells per cm. being not uncommon. The pneumonia cases also often showed a leukopenia, sometimes a slight leukocytosis, rarely over 12,000 to 14,000, and practically never over 20,000. The fatal cases usually showed a leukopenia. This is in very striking contrast to ordinary pneumonia.

Urine. The urine showed the ordinary type of febrile urine, a moderate amount of albumin and tube casts being present particularly in the pneumonia cases. Blood was rarely seen.

Treatment. The preventive measures taken were entirely along the lines of isolation and hygiene, and are dealt with under the heading Hospitalization.

No specific therapy was employed except in one instance, and since the causative organisms were not definitely known, no specific therapy could be used except in an entirely empirical way. At the beginning of the outbreak it was thought that the pneumonia was very likely due to the streptococcus, and therefore a sensitized streptococcus vaccine obtained through the kindness of Lieut.-Col. Harvey, R.A.M.C., from the vaccine laboratory, was tried in a small series of cases, without, however, any apparent benefit to the patient.

Oxygen has been used fairly extensively without any very striking results. The patients might or might not improve temporarily, but the course of the disease does not usually seem to be materially altered. At one hospital the Haldane field apparatus for oxygen administration was used. It was found to be a convenient way of giving oxygen, but beyond that no extraordinary beneficial effect was noted.

Further than this the usual symptomatic treatment of pneumonia has been carried out. Digitalis in some form has been commonly employed as well as camphor and other stimulants, and morphin or opium where indicated. At some of the hospitals urotropin has been used as routine.

Fluids have been forced by mouth, rectally and subpectorally.

It is felt that the hope lies in prophylaxis. Should the etiological factor be proved it should be possible to immunize against this disease. The immunity thus secured plus better methods of sanitation, particularly on board transports, should prevent a recurrence of the epidemic.

FIG. 1.—Showing methods of isolation ward in Base Hospital 29, Tottenham, England

HOSPITALIZATION. The matter of proper hospitalization of this sudden influx of contagious cases presented certain difficulties, but in general it was accomplished with all possible promptness, and except for the fact that in certain instances patients had to be transported for comparatively long distances on ambulance trains to reach hospitals, which is unquestionably undesirable, it is not thought that any cases suffered for want of proper hospital care.

In hospital, strict isolation was carried out from the start. Not only were the influenza cases and pneumonia cases segregated in separate wards, but in all the American hospitals they were screened one from another. The most usual method of screening was by means of sheets hung from wires. Fig. 1 shows this method in practice in a ward at Base Hospital 29.

Since the pneumonia may be due to a number of different infecting organisms, we believe that the importance of the prevention of cross infection by droplet infection by the use of screens cannot be too strongly emphasized.

In addition to these measures all personnel while on duty in the wards constantly wore gauze masks over the mouth and nose and were obliged to douche their nasal and oral cavities with some mild antiseptic solution once daily.

Pathological Anatomy.[4] A summary of the anatomical diagnoses recorded are shown in Table IV. Pneumonia was found in 99 per cent. of the fatal cases, and in 80 per cent. was apparently bronchial in distribution. The most common complication was fibrinous pleurisy, 39 per cent. Pleural effusions and empyemas were not uncommon, but were much less frequent than in the epidemics of streptococcus pneumonia occurring in the United States last winter. (See Table IV.)

Dilatation of the right heart was noted very frequently by some observers, less frequently by others. The difference in percentages noted may be due to individual differences in interpretation of the findings. A moderate enlargement of the spleen was noted in about half the cases and cloudy swelling of the liver and kidneys were recorded somewhat less frequently than one would expect in acute infections of this type. One finding which was rather common was chronic passive congestion of the liver.

Among the rarer lesions not noted in the table were peritonitis, which occurred in a few instances apparently as an extension from the pleurisy, and meningitis due to the influenza bacillus in two instances, to the streptococcus in one, to a mixture of these two organisms in one and in two instances to the pneumococcus. In cases in which the brain was examined it was common to find the pia distended with fluid and the cortex intensely injected. One might include under the complications the cases of meningococcus meningitis which followed bronchopneumonia, as both these meningitides and the pneumonias were probably sequelæ to the original grip infection.

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[4] The observations on the pathology and bacteriology of this epidemic are compiled from data and material contributed by workers at the various laboratories in this base section:

Major W. W. Williams, Base Hospital No. 29.
Captain A. W. Stahl, Base Hospital No. 204.
Captain G. A. Sorgatz, Camp Hospital No. 40.
Captain M. B. Beecroft, Base Hospital No. 37.
Lieut. R. S. Stauffer, Base Laboratory.
Lieut. R. R. Simmons, Base Hospital No. 33.
Lieut. F. B. Harrington, Camp Hospital No. 35.
Lieut. T. M. Marks, Base Hospital No. 40.
Lieut. D. C. Lee, A. R. C. M. Hospital No. 4.
Lieut. E. D. McBride, A. R. C. M. No. 21.

TABLE IV.—SUMMARY OF AUTOPSIES.

	B. H. No. 204.	B. H. No. 40.	B. H. No. 37.	Base Lab. (B. H. No. 35).	C. H. No. 40.	A. R. C. No. 4.	B. H. No. 29.	A. R. C. No. 21.	B. H. No. 33.	Total.	Per cent.
Total autopsies	53	2	25	25	21	127	19	21	101	394	
Lungs:											
Bronchitis	32	2	17	0	0	30	7	21	101	210	53.3
Bronchopneumonia	52	2	17	21	19	126	19	6	52	314	79.7
Lobar pneumonia	1	0	7	4	2	0	0	12	49	75	19.0
Abscess of lung	0	0	2	2	1	10	0	0	5	20	5.1
Gangrene of lung	0	0	0	0	0	0	0	0	0	0	0
Infarcts of lung	0	0	0	2	0	0	1	0	0	3	0.8
Pleuræ:											
Fribrinous pleurisy	16	0	13	19	11	59	4	2	29	153	38.9
Pleural effusion ser. Slight	12	0	1	10	1	10	4	5	24	67	17.07
Moderate	15	1	2	1	5	8	3	2	4	41	10.4
Marked	10	0	2	0	6	4	4	1	3	30	7.6
Pleural effusion pur. Slight	1	0	0	0	0	3	0	0	6	10	2.5
Moderate	5	0	0	1	4	6	1	1	5	23	5.8
Marked	1	1	2	4	0	5	1	0	3	17	4.3
Pleural adhesion	23	1	12	15	11	13	5	6	24	110	27.9
Pneumothorax	0	0	0	0	0	5	0	0	0	5	1.27
Pericardium:											
Fibrinous pericarditis	2	0	1	3	3	5	2	0	3	19	1.81
Serous pericarditis	40	2	1	10	14	17	9	7	8	108	27.4
Purulent pericarditis	1	0	0	3	1	3	0	0	0	8	2.0
Heart:											
Dilatation, right side	3	1	17	11	8	53	7	8	0	108	27.4
Dilatation, left side	0	0	0	1	8	0	1	2	0	12	3.0
Myocarditis, acute	0	0	0	0	0	0	0	0	0	0	0
Endocarditis, acute	1	1	0	0	0	0	0	0	1	3	0.8
Liver:											
Perihepatitis, acute	0	0	0	0	3	1	1	0	0	5	1.3
Parenchymal changes	1	0	12	8	2	88	2	0	2	115	29.2
Spleen:											
Perisplenitis, acute	0	0	0	0	9	1	0	0	0	10	2.5
Enlarged soft spleen	15	2	15	12	8	95	3	4	18	172	43.6
Other parenchymal changes	0	0	0	1	0	0	0	0	0	1	0.25
Kidneys:											
Simple congestion	18	2	9	2	10	38	2	8	0	89	22.6
Cloudy swelling	6	0	4	19	5	42	0	0	2	78	19.8
Actual acute nephritis	0	0	2	7	5	35	0	0	0	49	12.4
Accessory nasal sinuses:											
Number of examinations	17	0	0	9	0	6	0	0	0	32	
Catarrhal sinusitis	0	0	0	0	0	5	0	0	0	5	15.6
Purulent	16	0	0	5	0	1	0	0	0	22	69.0

NASAL SINUSITIS. A lesion which interested us considerably was a purulent inflammation of the sphenoid or ethmoid sinuses. This seldom gave pronounced clinical symptoms, but was found in 69 per cent. of the cases in which the sinuses were examined postmortem—at one hospital in 16 out of 17 cases. It was striking from the bacteriological side that the same organisms as were found in these infected sinuses, were usually present in the consolidated lung of the same case. This fact suggested that these sinuses might be the primary focus of infection, a possibility which was also suggested by Major H. E. Robertson[5] in connection with an earlier influenza epidemic.

PERIBRONCHIAL PNEUMONIA. The most important lesion apparently was the pneumonia, and this varied remarkably from case to case, both anatomically and bacteriologically. In the earlier cases the lung showed fairly uniform consolidation, approximating a typical lobar pneumonia, and differing from it chiefly in the hemorrhagic appearance of the lung and the moistness of the consolidated areas. From some of these massive pneumonias only the influenza bacillus was recovered on culture. In the later cases the consolidation was remarkably patchy, and toward the end of the epidemic cases began to appear which showed macroscopically a purulent bronchitis and practically no pneumonia. These last cases resembled strikingly those seen in an epidemic in France in December, 1917, which were uncomplicated influenza bacillus infections. Of the bronchopneumonias many showed minute abscesses, some showed extensive hemorrhages, many pronounced edema of the unconsolidated areas and in those with pleural effusions the picture was complicated by a compression atelectasis. These pneumonias were anatomically not one disease but a variety of terminal processes grafted on some original infection.

It is impossible, therefore, to describe any lesion typical of all cases. However, the majority of the lungs examined had certain common characteristics. They were, as a rule, very voluminous and contained considerable air, but firm nodules could be felt in the cushiony lung substance. Toward the posterior portion of the upper lobe and the base of the lower lobe these discrete masses were replaced by a solid block of airless lung. On section the consolidated areas stood out rather sharply, and frequently were in the form of a pyramid, with the base against the pleural surface of the lung. Scattered through them were dots and lines of opaque yellowish-gray material, frequently with points of black anthracotic pigment in the center, varying from 0.5 mm. to 3 or 4 mm. in thickness. In some cases these gray areas were firm and in others could be squeezed out as drops of thick pus. Between these foci the consolidated tissue was granular, rather moist, sometimes gray, but more frequently a brilliant crimson. Again, between these completely consolidated masses the lung tissue was often nearly solid, moist and red, apparently representing what Baehr has described as an explosive terminal extension of the pneumonia.

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[5] Jour. Am. Med. Assn., May 25, 1918.

The arterial trunks were free, the larger bronchi and trachea intensely inflamed with bright crimson mucosa and a small amount of purulent or fibrinous exudate.

Microscopically the most interesting changes were in the smaller bronchi. These were frequently represented by a collection of leukocytes bordered on one side by the mucosa and muscular wall of the bronchus and on the other side emerging indefinitely with alveoli filled with purulent exudate. In other cases only shreds of bronchial epithelium could be made out, remaining here and there along the wall, and in many sections no remnants of the bronchial wall could be made out, the bronchi being apparently represented by little pools of pus, each lying close to an artery and a vein and bordered only by inflamed alveoli. The air cells immediately around these disintegrated bronchi were usually filled with pus, but beyond these was a zone in which the exudate was, as a rule, croupous, containing considerable fibrin, with red cells, leukocytes and epithelia in varying proportions. Not infrequently there were extensive areas of hemorrhage, in some of which the red cells lay within well-preserved alveoli and in others the lung framework had been swept away.

It has not been possible to study all the cases microscopically or to correlate all the histological pictures with the bacterial findings. It appeared, however, that the feature common to nearly all the cases was what we may call an ulcerative bronchitis and peribronchial pneumonia, the ulcerative process often resulting in a complete dissolution of the walls of the smaller bronchi. The breakdown of this line of defence would make easy the access of any pathogenic organisms in the bronchial tract to the already injured lung tissue. This offers a possible explanation of the variety of bacteria encountered not only in the lung but in the other viscera and the blood stream and also of the frequency of mixed infections.

Bacteriology. The preliminary examination of sputum from the early cases of pneumonia showed a great variety of organisms, with no striking predominance of one type, and it was thought that the surest evidence as to the identity of the infecting agent could be obtained from cultures postmortem. The results of cultures from consolidated lungs made at the various laboratories in the base section are summarized in Table V. Here, again, a great variety of bacteria were found, the organism most frequently met with being one closely resembling the influenza bacillus of Pfeiffer. (See Table V.)

TABLE V.—CULTURES FROM LUNGS POSTMORTEM.

	Base Laboratory (1st series).			Base Laboratory (2d series).			Base Hospital No. 33.			Base Hospital No. 29.			Base Hospital No. 37.			A. R. C. M. Hospital No. 4.			Camp Hospital No. 40.			Total.			
Number of cases	48 cases.			16 cases.			55 cases.			22 cases.			15 cases.			8 cases.			24 cases.			188 cases.			
	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Alone.	Mixed.	Total.	Per ct.
B. influenzæ	13	24	37	0	8	8	5	15	20	0	0	0	0	5	5	1	4	5	0	8	8	19	64	83	44
Pneumococcus	3	12	15	0	7	7	1	6	7	18	4	22	3	7	10	2	5	7	6	10	16	33	51	84	44
Streptococcus hemolyticus	1	5	6	3	4	7	24	8	32	0	4	4	3	3	6	0	1	1	8	2	10	39	27	66	35
Staphylococcus aureus[4]	3	6	9	0	6	6	..	..	..	..	..	..	0	3	3										
Streptococcus viridans[4]	0	1	1	0	4	4	3	2	5																
Meningococcus	1	1	2	0	1	1	11	1	2	..	..	..	..	..	..	..	..	..	..	..	..	2	3	5	2⅔

[4] Totals and percentages for Staphylococcus aureus and Streptococcus viridans are not included because these organisms were not recorded by all observers.

INFLUENZA BACILLUS. All the organisms reported as influenza bacillus gave characteristic delicate growth on subculture on blood-agar, and morphologically were minute cocco-bacilli or minute rods. In older cultures long thread-like forms and also swollen oval or pear-shaped forms were sometimes seen. A considerable number of these strains were planted in parallel on serum-agar and on whole blood-agar, and all those tested showed characteristic inability to grow on serum-agar. On account of the rush of work it was impossible to complete the identification of all strains, especially during the first part of the epidemic. Up to the present we have also not succeeded in producing a satisfactory agglutinating serum for the identification of these organisms. As far as observed, however, they correspond to the usual description of B. influenzæ.

PNEUMOCOCCI. The majority of the pneumococci isolated were tested for bile solubility and also for agglutinability in Group I, II, and III sera. At Base Hospital 29 inulin fermentations were also carried out. At this laboratory all the pneumococci recovered postmortem belonged to Group IV. At the base laboratory we obtained two strains of Group I, two strains of Group II, five strains of Group III and 19 strains of Group IV. Of those classed as Group IV several showed a slight agglutination in 1 to 20 dilution both in Group I and Group III serum and one strain agglutinated slightly in all three sera. The reactions, however, in these cases were so feeble when compared with the complete agglutination which occurred when the homologous strains were employed that these organisms were classified as Group IV. Whether many of them may belong to one subtype of this heterogeneous group has not yet been determined.

GRAM-NEGATIVE DIPLOCOCCI. In the earlier cases no record was made of the finding of Gram-negative diplococci in cultures from the lung, as they were regarded as being saprophytes from the bronchi. On account of the frequency with which they occurred, not only in cultures from the lung but also in cultures from the heart's blood or spleen, the later strains were more carefully studied. Of these one pure culture obtained from the lung agglutinated in Type I antimeningococcus serum (Gordon), and one which was found mixed with influenza agglutinated in Type II. Another one associated with the pneumococcus agglutinated with Lederles's polyvalent serum, but failed to agglutinate with any of Gordon's type sera. Of the others most strains produced pigment on subculture or else grew in a dry mass which would not emulsify and were discarded. The few which gave satisfactory emulsion were tested but were not agglutinated by any sera at our disposal. Two strains of a number submitted by Capt. W. Fletcher, R.A.M.C., failed to agglutinate in any of the "Gordon" type sera but agglutinated in Type C of the Pasteur Institute. Two cultures were also obtained by Lieut. Simmons. Of the strains mentioned below, isolated by

Lieut. Stauffer from the sputum and nasopharynx, one agglutinated in polyvalent antimeningococcus serum "Flexner" but not in any of the "Gordon" type sera. The remainder were inagglutinable. It is interesting that apparently 5 cases of meningococcus-pneumonia occurred in this series.

CULTURES FROM OTHER VISCERA. The results of cultures from heart's blood and other viscera are summarized in Table VI. As the rountine procedure varied at different hospitals this series is far less complete. Here, again, the picture is confusing. In one case the influenza bacillus, streptococcus and pneumococcus were all isolated from the heart's blood. Another confusing factor was that Staphylococcus albus and Gram-negative diplococci of the flavus and catarrhalis types were not infrequently recovered from the heart's blood or from the spleen, which suggested that in these cases the bacterial flora of the respiratory tract gained easy access to the blood stream either shortly before or after death. One fact that seemed evident was that the pleural and pericardial effusions were due either to the pneumococcus or streptococcus and not to the influenza-bacillus. (See Table VI.)

In order to bring out more clearly these variations the reports from the various laboratories have been recorded separately in these tables and the records at the base laboratory divided into those obtained during the first part of the epidemic, and a second series, done during the later part when the cases were less numerous, and it was possible to work out the cultures more thoroughly.

DISCUSSION OF POSTMORTEM CULTURES. The striking feature of the postmortem bacteriological findings was the great variety of bacteria recovered. The findings varied first according to the period of the epidemic. During the first part of the epidemic the influenza bacillus was present in most of the cases as far as our personal observation went, and frequently was the only organism recovered from the consolidated lung. As the epidemic progressed this organism was less frequently recovered, and instances of pure influenza pneumonia were extremely rare. The findings also varied according to the portion of the lung examined. Several bacteriologists reported that in cases in which the recently involved portion of the lung gave a pure or a nearly pure culture of B. influenzæ the older areas showed pyogenic cocci alone, being mixed with a few influenza bacilli. The findings also varied very strikingly from place to place. At Base Hospital 33 over 50 per cent. of the cases showed hemolytic streptococci, while at most of the hospitals this type of infection was rare, and at Base Hospital 29, pneumococcus Group IV was recovered from every case autopsied.

The majority of the patients in this series came from one transport and became sick while they were in close contact with each other, and were later distributed to the various hospitals in the section. It seemed clear, on epidemiological grounds, that the origi-

TABLE VI.—CULTURES FROM OTHER VISCERA.

	Hearts' blood.				Spleen.			Liver.		Pleural fluid.			Pericardial fluid.				Sphenoid sinus.		
	Base Laboratory (1st series).	Base Laboratory (2d series).	Base Hospital No. 33.	Camp Hospital No. 40.	Base Laboratory (1st series).	Base Laboratory (2d series).	Camp Hospital No. 40.	Base Laboratory (1st series).	Base Laboratory (2d series).	Base Laboratory (1st series).	Base Laboratory (2d series).	Base Hospital No. 33.	Camp Hospital No. 40.	Base Laboratory (2d series).	A. R. C. M. Hosp. No. 4.	Camp Hospital No. 40.	Base Laboratory (1st series).	Base Laboratory (2d series).	Base Hospital No. 33.
Number of cases examined	..	17	58	26	..	17	26	..	17	1	5	6	26	5	10	26	11	5	5
Number from which growth was obtained	5	13	32	15	7	9	7	6	12	1	5	6	6	5	10	9	11	5	5[7]
B. influenzæ	3	1	1	0	4	0	0	1	0	0	0	1	0	0	0	0	9	4	4
Pneumococcus	2	6	5	12	1	2	5	2	3	1	2	0	4	2	10	7	8	0	0
Streptococcus hemolyticus	0	6	23	3	0	4	2	0	5	0	4	5	2	3	6	2	1	0	0
Staphylococcus aureus	0	2	3	0	1	3	0	3	6	0	1	0	0	1	0	0	3	3	0
Streptococcus viridans	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0

[7] One case Staphylococcus albus only.

nal infection must have been due to one microörganism, and we can only conclude that the various infections observed postmortem were terminal affairs. The fact that certain types of infection predominated at certain hospitals suggested that the terminal infection occurred after admission to the hospital.

The only organism found which could well have been the primary infecting agent was the influenza bacillus, and this was recovered from only 44 per cent. of all the cases. This figure may well be lower than the actual fact on account of the difficulty often found in cultivating this organism when we know it to be present. Its prevalence during the early part of the epidemic and in the recently involved portions of the lung both pointed toward its being the primary agent. In order to secure more definite evidence on this point, cultures were made from blood and from sputum of patients during life.

Blood Cultures. The blood cultures gave little information. When taken from uncomplicated influenza they were uniformly negative. A small percentage of those taken from cases of pneumonia showed the presence of pneumococcus or streptococcus.

TABLE VII.

	Base Hospital No. 204.	Base Hospital No. 33.	Base Hospital No. 20.	A. R. C. Hospital No. 4.
Number of cultures . .	20	16	70	20
Pneumococcus	0	0	4(6%)	8
Streptococcus hemolyticus	0	0	2(3%)	0
Negative	20	16	64	12

Sputum Cultures. The cultures from sputum were more helpful, though by no means conclusive in their results. Thirty-two cases from "Transport 56," only 3 of which had definite signs of pneumonia, were studied by Lieut. Stauffer. The sputum was obtained at the bedside, washed and injected immediately into the peritoneum of a mouse, and also plated directly on blood-agar. At the same time a swab from the nasopharynx was plated on blood-agar. (See Table VIII.) The influenza bacillus was recovered from the sputum in 75 per cent. of the cases and slightly less often from the nasopharyngeal cultures. The pneumococcus was found in the sputum in 10 cases and in the nasopharynx in 6. Seven of the latter were tested for agglutinability and bile solubility and 6 found to belong to Group IV and one to Group II. In regard to the mouse inoculation, it is worth noting that the influenza bacillus was frequently obtained from the heart's blood of the mouse after death, and that the pneumococci, although frequently found in the blood or peritoneal cavity of the mouse, never grew in profuse and almost pure culture in the peritoneum, as is usually the case when mice are injected with the sputum from typical lobar pneumonia.

TABLE VIII.—CULTURES FROM SPUTUM AND NASOPHARYNX.

Thirty-two cases of influenza without pneumonia from "Transport 56."

	Sputum, direct culture.	Sputum injected into mouse.		Naso-pharyngeal swab cultures.
		Peritoneum.	Heart.	
Number of cases examined	29	22	22	24
Influenza bacillus	22	16	15	19
Pneumococcus	9	10	10	6
Streptococcus hemolyticus	1	0	0	3
Staphylococcus aureus	7	7	1	1
Streptococcus viridans	2	2	1	1
Gram-negative diplococci	13	6	4	15

These observations were not made until the epidemic in troops from this transport had begun to subside, and it was quite possible that the original infecting agent might be missed. At this time, however, a number of secondary cases developed among the hospital personnel and among troops in contact with the men of this transport at a rest camp. Forty-eight sputum cultures from such cases made by Lieut. F. B. Harrington (See Table IX) showed the presence of the influenza bacillus in 32; and in 23 of the cases it was found practically in pure culture, being mixed with only a few colonies of the organisms ordinarily found in the upper respiratory tract.

TABLE IX.—SPUTUM CULTURES FROM CAMP HOSPITAL NO. 35, OCTOBER 10 TO OCTOBER 31.

Influenza alone	23
Pneumococcus alone	7
Influenza and pneumococcus mixed	9
Streptococcus hemolyticus	5
Influenza pneumococcus and streptococcus mixed	1
Streptococcus hemolyticus and pneumococcus	1
Streptococcus and influenza	2

At Base Hospital 29, 70 sputum examinations were made—39 by mouse inoculation and 31 by the Avery tube. The results were:

	Cases.	Per cent.
Pneumococcus, Type II	5	4
Pneumococcus, Type III	7	10
Pneumococcus, Type IV	60	86

The influenza bacillus was not recovered. Of sputa from 7 cases of advanced pneumonia at American Red Cross M. Hospital 4, 2 showed pneumococci alone; 4 pneumococcus and B. influenzæ; and 1 pneumococcus and streptococcus.

SUMMARY. 1. Epidemiological, clinical and pathological observations of the epidemic of influenza as seen in American troops in England are presented.

2. From the epidemiological findings it appears that we are dealing with a highly contagious acute respiratory tract disease. It further appears that the mortality is about twice as high on board transports as on shore—namely 4 per thousand per month at sea and 2 per thousand per month on shore.

3. The most effective measures found for controlling the outbreak and for diminishing the mortality have been found to be (*a*) prompt isolation of all men showing temperatures and (*b*) increasing the amount of space allotted to a man. No conclusive evidence is at hand that masking and prophylactic spraying are effective, but the authors believe that these measures may properly be carried out, but are not to be solely relied upon.

4. In the matter of hospitalization it appears pretty definitely that it is highly important that cases be moved as little as possible and that they be got to bed with a minimum of delay. Long journeys in hospital trains are distinctly inadvisable.

5. In regard to the higher mortality seen at sea it is probable that various debilitating circumstances, such as unpalatable and hence insufficient food, broken and insufficient sleep, poor ventilation, overcrowding and exposure to cold and wet, all may have served to lower the individual resistance to the disease. But it is probable that the high mortality was determined not so much by these factors as by the virulence of the infecting organisms. It must be borne in mind that the troops were all newly recruited and that they left cantonments where a highly virulent organism was prevalent.

6. Clinically, it seems probable that the original infection is an entity. That when uncomplicated the mortality is nearly zero, but that bronchopneumonia frequently develops and is responsible for practically all the deaths. The type of bronchopneumonia is unusual. It may be exceedingly fulminating and almost explosive in extension, or it may be subacute, running a course of ten days to two weeks. It is usually associated with a purulent bronchitis. The cause of death in the fulminating cases may be suffocation, in the less rapid ones toxemia. The peculiar features of the pneumonia are the deep cyanosis, with no cause obvious in the circulation, the absence of pain and orthopnea, the frequent epistaxis, the purulent and blood-streaked sputum and the leukopenia.

7. No curative measures of value have been found. In the pneumonia, oxygen administered may or may not alter the cyanosis, but in any event does not seem to alter the course of the disease. Treatment in general must necessarily be entirely symptomatic. Venesection and saline infusion have not shown any beneficial effect. Digitalis has been used extensively, but in the majority of cases there is no clear-cut evidence of cardiac incompetence.

8. As to etiology it is impossible, from the reported findings, to draw definite conclusions as to the primary infecting organism. The streptococcus, pneumococcus, staphylococcus and meningococcus were found so irregularly that we believe they can be excluded as secondary invaders. The influenza bacillus was found postmortem frequently, but by no means constantly. However, it was found more frequently in the early part of the epidemic than in the late, and in the early cases it was often the only organism in the consolidated lung. It was found more frequently in the freshly consolidated lung than in older lesions. It was also found with considerable regularity in the sputum and nasopharynx of grip cases uncomplicated by pneumonia. These facts seemed to indicate that the Pfeiffer bacillus was the primary cause of the epidemic, though the evidence is not conclusive. The observations of Charles Nicolle at Tunis of the presence of a filterable virus offer an alternative explanation. In conclusion, we can only state that this epidemic was due to infection by either the bacillus of Pfeiffer or by some microörganism not recoverable by the methods employed.

THE UNIDENTIFIED PANDEMIC DISEASE (INFLUENZA?).

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The pandemic of acute respiratory disease which started in Europe in 1918 is still unidentified. Clinically and pathologically it is a new disease, differing widely from familiar maladies and epidemics within our experience or described in the literature of medicine. The etiology, in fact, of epidemics which have come down through history as "influenza" is fully as uncertain as the present one, during which the opportunities for accurate laboratory study have been unprecedented. The ultimate solution of this problem must rest with the bacteriologist.

The disease is still epidemic in many quarters and the persistence of scattered cases when the epidemic first appeared makes it extremely probable that it will be added to the category of endemic contagious diseases. The prompt recognition of isolated cases is exceedingly important for the individual and the community. An opportunity for the study of the disease has been offered in our military hospitals, which is not liable to be duplicated.

The clinical material on which this communication is based comprises about 1500 cases under observation from the beginning of the epidemic until the middle of December at U. S. Army General Hospital No. 1 (Columbia War Hospital), Williamsbridge, N. Y.;